FCC DOCKET CC NO. 98-121
AFFIDAVIT OF ROBERT V. FALCONE

I declare under penalty of perjury that the foregoing is true and accurate to the best of my knowledge and belief.

Executed on July 22, 1998.

Robert V. Falcone

Robert V. Falcone

District of Columbia (ss)

SUBSCRIBED AND SWORN TO BEFORE ME this 22 day of July, 1998.

Notary Public

CHRISTIANE YAU
Comm. #1087602
NOTARY PUBLIC - CALIFORNIA
City & County of San Francisco
Comm. Exp. Feb. 15. 2000

My Commission Expires: Feb 15, 2000

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AFFIDAVIT OF ROBERT V. FALCONE**

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23 Excerpt of Affidavit of Gerard Mulcahy, Petition of New York Telephone Company for Approval of its Statement of Generally Available Terms and Condition Pursuant to Section 252 of the Telecommunications Act of 1996 and Draft Filing of Petition for InterLATA Entry Pursuant to Section 271 of the Telecommunications Act of 1996, NY PSC Docket No. 97-C-0271, ("Mulcahy Aff.")

24 Excerpt of Testimony of Donald Albert, Bell Atlantic, Proceeding on Motion of the Commission To Examine Methods by which Competitive Local Exchange Carriers Can Obtain and Combine Unbundled Network Elements, NY PSC, Case No. 98-C-0690, Tr. 257 (June 29, 1998)

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32 Iowa Utilities Bd., Docket Nos. AIA-96-1; AIA-96-2, Final Arbitration Decision on Remand, at pp. 22-23 (May 15, 1998)

33 See In the Matter of the Interconnection Contract Negotiations, PSC of Utah, Docket Nos. 96-087-03 and 96-095-01, Order on Reconsideration (June 9, 1998)

34 In the Matter of AT&T Communications of the Mountain States, Inc. Petition for Arbitration, Idaho PUC, Case No. USW-T-96-15, Order No. 27236 (Dec. 1, 1997)

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37 Letter of Quinton Sanders, BellSouth, to Ray Crafton, AT&T, March 17, 1998

38 Letter of Quinton Sanders, BellSouth, to Raymond Crafton, AT&T, June 18, 1998

39 Commission Recommendation, Public Utility Co. of Texas, Investigation of Southwestern Bell Telephone Company's Entry Into the Texas InterLATA Telecommunications Market, PUC Project No. 16251 (adopted May 21, 1998)

40 Initial Staff Report, California Public Utilities Commission, Telecommunications Division, Pacific Bell and Pacific Bell Communications Notice of Intent to File Section 271 Application For InterLATA Authority in California, Case No. U 1001 C (July 10, 1998)

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42 In re The Investigation and Suspension of Tariff Sheets filed by US West Communications, Inc. With Advice Letter No. 2617, Regarding Tariffs For Interconnection, Local Termination, Unbundling, and Resale of Services, Colorado PUC, Docket No. 96S-331T, Decision Regarding Commission Authority to Require Combination of Network Elements, Decision No. C98-267 (Feb. 18, 1998)

43 Investigation into New England Telephone and Telegraph Company's (NET's) tariff filing re: Open Network Architecture, including the unbundling of NET's network, expanded interconnection, and intelligent networks in re Phase II, Module Two, Vermont Public Service Bd., Docket No.5713, Order of Hearing Examiner, (May 12, 1998)

44 Consolidated Petitions Pursuant to Section 252(b) of the Telecommunications Act of 1996, Massachusetts D.P.U./D.T.E. 96-73/74 et al. (March 13, 1998)

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ATTACHMENT 1

STATE OF NEW YORK
PUBLIC SERVICE COMMISSION

Proceeding on Motion of the Commission to Examine Methods by which Competitive Local Exchange Carriers Can Obtain and Combine Unbundled Network Elements	**Case 98-C-0690**

AFFIDAVIT OF AMOS E. JOEL, JR.

Amos E. Joel, Jr., being first duly sworn upon oath, does hereby depose and state as follows:

INTRODUCTION

A. Personal Background

1. I am an executive consultant in the field of telephone switching, a position which I have held since 1983 when I retired from Bell Telephone Laboratories, after 43 years of service with that company.

2. I graduated from Massachusetts Institute of Technology with a Bachelors degree in electrical engineering in 1940 and a Masters degree in electrical engineering in 1942.

3. Following graduation I went to work for Bell Labs, where I initially worked on fundamental development studies of telephone switching systems. During the Second World War, I designed circuits for early general purpose digital computers. My major area of responsibility was the development of secret message coding and decoding machines for military and diplomatic use.

4. Following the War, I prepared and taught a course on switching systems and circuit design for employees of various companies within the Bell system. Subsequent to that, I was involved in the design of automatic message accounting

equipment to automate telephone billing and in fundamental engineering studies of Electronic Switching Systems (ESS).

5. From 1952 to 1961, I supervised development planning for the Bell System's first electronic telephone switching systems and helped prove the concept of electronic switching for use in the nation-wide network. From 1961 to 1967, I was responsible for the development of the Traffic Service Position System (TSPS), used to automate the work of telephone operators, and the Automatic Intercept System (AIS), used to automatically handle calls to non-working numbers. Similar systems are still in use throughout the United States.

6. I was also active in the early studies of Cellular Mobile Radio Systems and am the named inventor in one of the basic patents on the switching aspects of this service. In addition, I am the named inventor in over 70 additional patents in the telephone switching field. These patents include: 2,925,957, AMA Assembler-Computer (largest U.S. Patent issued to that time), which is a patent on an early computer used to itemize calls on telephone bills; 2,761,900 and 2,676,209, Automatic Handling of Long Distance Coin Calling, which are basic patents for long distance calling from coin telephones; 3,484,560, Traffic Service Position System No. 1, the basic patent on the widely used system for operator assisted calls; 3,571,517 and 3,143,601, Automatic Intercept Number Identification System, a system used to announce the number reached for numbers changed or no longer in service; 3,663,762, Mobile (Cellular) Communication Systems, the basic patent for today's popular Cellular Radio Communications; 3,731,000, Equipment for Switching Calls from Remote Trunk Groups to Distant Centralized Operator Service Center; 4,007,339, Arrangement for Serving Operator Assistance Calls Requiring Routing Back to Originating Office (Remote RSPS) (RTS); and 4,736,462, Photonic Switching.

7. One other patent deserves particular mention here because of its direct relevance to this proceeding. In a patent issued in 1971 (3,562,435, Automated

Main Distributing Frame), I pioneered the concept of an automated main distributing frame, which improved upon the existing Main Distribution Frame, which had been first patented in 1893.

8. I am a member of the National Academy of Engineering, a life fellow of the Institute of Electrical and Electronics Engineers (IEEE), a fellow of the American Academy of Arts and Science, and a member of the Association of Computing Machinery, the American Association for the Advancement of Science, and the Engineering Honor Society, Sigma XI. I have been active in IEEE affairs for some years and have chaired a number of technical committees and boards at local, national, and international levels. I was Chairman of the IEEE New York section from 1963 to 1964 and President of the IEEE Communications Society from 1973 to 1975.

9. In 1972, I was co-recipient of the New Jersey Research & Development Council's Outstanding Patent Award for the concept of a new operator telephone-traffic service system. In 1976, I was the co-recipient of the IEEE Alexander Graham Bell Medal for the conception and development of electronic switching systems and their effective introduction into a nation-wide telephone system. In 1981, I received the Franklin Institute-Stuart Ballantine Medal for my achievements in bringing into being electronic switching and for my contributions toward the many functions it made possible for modern telecommunications.

10. In 1983, I received the International Telecommunication Union Centenary Prize in recognition of outstanding work in the field of electronic switching and other significant contributions to the development of communications. In October, 1984, I received the Columbian Medal from Genoa, Italy in recognition of my stature in the telecommunications field and particularly in telephone switching.

11. In 1989, I was awarded the Kyoto Prize in advanced technology from the Inamori Foundation of Japan in recognition of my achievements in the field of

telecommunications and in the same year was named one of New Jersey's Inventors of the Year by the New Jersey Institute of Technology.

12. In May, 1992, I received the IEEE's highest award, its Medal of Honour, and in the same year was awarded the Charles E. Scribner Trophy by American Telephone and Telegraph Company ("AT&T") in recognition of my many important patents, including the cellular radio patent. In 1993, President Clinton presented me with the United States' highest engineering award, the National Medal of Technology.

13. I have taught and lectured extensively in the United States and abroad, and have authored numerous articles on switching subjects that have appeared in encyclopedias and the technical press. My reference texts include "Electronic Switching: Central Office Systems of the World," published by IEEE Press (1976), "Electronic Switching: Digital Central Office Systems of the World," published by IEEE Press (1982), and "History of Engineering and Science in the Bell System - Switching Technology," published by Bell Telephone Laboratories, Inc. (1982). In addition, I was a major contributor to "Fundamentals of Digital Switching," published by Plenum Publishing (1983 and 1990), and co-author of "Electronics, Computers and Telephone Switching," published by North Holland (1990). I co-authored a study for Probe Research entitled "The Future of the Central Office," and a chapter in the book "Technological Competitiveness" by IEEE Press.

14. Although I retired from Bell Laboratories 15 years ago, I have made it a point to keep up to date with the progress and changes in the industry. I have been involved in court proceedings regarding patent validity and infringement and have been engaged to evaluate new products, systems and services.

B. Overview

15. As I understand the law, under the 1996 Telecommunications Act and the rules subsequently adopted by the Federal Communications Commission,

incumbent local exchange carriers (ILECs) must give competitive local exchange carriers (CLECs) access to their "network elements" as defined by the FCC and the states on an unbundled basis. Moreover, ILECs are required to provide their network elements in a manner that allows CLECs to combine them in order to provide telecommunications service.

16. In this proceeding, my understanding is that the Commission is attempting to evaluate different methods by which the ILECs would provide network elements on a separated basis, but in a manner that allows CLECs to combine them. I have reviewed the submission of Bell Atlantic - New York ("Bell Atlantic"), which proposes to permit CLECs to combine the unbundled loop and the unbundled switch port through substantial manual processes at the Main Distribution Frame (MDF). I have also reviewed an affidavit of Robert Falcone that criticizes collocation proposals and proposes to use the recent change capability of the switch to combine the loop and switching elements. I have been asked to evaluate, from an engineering and technical viewpoint, the merits of these proposed methods for combining network elements.

17. Accordingly, in Part I, I identify and discuss the criteria that have been used by engineers to design and improve telecommunications networks. Using some examples from the history of network design, I show that, as the telephone network has evolved, many functions that once were performed entirely through manual and mechanical processes are now automated and performed electronically in accordance with software-controlled programming.

18. Then, in Part II, I review different methods for combining network elements, considering the engineering and technical aspects of the methods proposed. I conclude that the various recombination methods proposed by Bell Atlantic, which all involve manually connecting analog loops and cross-connects, introduce additional manual processing, hardware, and points-of-failure of the sort that engineers have worked for years to eliminate from the network. Bell Atlantic's proposals are inconsistent with

over a century of progress in telephone network engineering. From an engineering and operational standpoint, it would be preferable for CLECs to be able to use software to combine network elements.

I. PRINCIPLES AND HISTORY OF NETWORK DESIGN

A. Criteria for Designing Networks

19. Throughout its 120-year history, the telephone network has grown not only in size but in functionality and reliability. Today, a single switch can process well over a million calls per hour with virtually no errors, all while offering advanced functions and features. As new technology has been introduced, engineers have been able not only to expand service offerings but to improve the reliability and dependability of the service. And, at the same time that the quality of service has increased, engineers have used new technology to reduce the effort, time, and expense required to provide service.

20. While there is no magic to any particular formulation of design criteria, it is clear to me that three factors are important. Improvements in design are those changes that make the network either (1) more reliable (by minimizing outage or need for repair and maintenance, thereby ensuring that the network provides the service that has been promised); (2) more functional (by increasing the variety or enhancing the power and flexibility of the services that it offers); or (3) more efficient (by reducing the expense needed to provide a given function, either by using existing resources more economically, replacing them with more powerful substitutes, or eliminating the need for them altogether).

21. To achieve these goals, engineers seek to adjust the balance between the three basic building blocks of the network -- terminals, transmission (whether over loops or trunks), and switching. The best engineering solution is generally the simplest one. A simpler network design is usually preferable because adding

unnecessary components to the network disrupts the balance among the elements and decreases overall efficiency.

22. Accordingly, one recurring theme of network design has been to reduce the number of network components within each network building block by incorporating in each component more and better defined functionality. A simpler network with fewer components minimizes the number of points of failure, which are places in the network where manual activity occurs and creates an opportunity for error. It also permits more efficient trouble detection, identification, and repair, improves efficiency, and lowers costs. Another important theme has been to reduce the amount of manual activity needed to make the network operate. Like unnecessary hardware, manual activity brings with it opportunity for human error, as well as increases in delay and cost, that generally can be avoided through automation.

B. History of Network Design

23. There are many examples of improvements to the basic network building blocks over the last century that illustrate these themes. It may be particularly useful here to consider some of those involving transmission from the customer's premises to the central office (in particular the loop and MDF), and switching.

1. The Loop and the MDF.

24. We have all seen pictures taken in the late 19th century showing telephone poles with many crossarms or depicting men working on the roofs of telephone buildings connecting telephone lines from these poles to tie down points. See Attachment 1. This is the way telephone lines (or "loops" as they now are called) were brought to central offices, appropriately called "wire centers," in the very early days. Engineers recognized that the mess on top of telephone buildings could not continue to grow without impairing network functions. Accordingly, cables were developed to

reduce space and to replace the open wires. In large cities, cables were also removed from poles and placed in ducts under the streets.

25. Although perhaps less well known from photographs, the enormous number of wires also created a mess in the central office. In attachment 2, I show a photograph taken approximately in that time period that shows a central office with wires running in every direction. Likewise, engineers recognized that network efficiency could be improved by bringing these cables into the central office building in an orderly manner. In 1893, two inventors obtained a patent on an important invention -- a "distributing frame" that became known as the "MDF." See attachment 3.

26. This frame brought order to the task of connecting the equipment inside the central office building with the outside lines. Cables from the street were brought into the central office building to vertical terminal strips and protectors located on one side of the MDF. Lines from switchboards were then brought to horizontal terminal strips on the other side of the MDF, and arrayed in numerical or directory number order. To associate the outside plant with the inside equipment, wire "cross" connections were made between a pair of vertical and horizontal terminals.

27. The invention of the MDF improved efficiency in the central office: Most obviously, arranging the wires in a more orderly fashion made it easier to maintain, test, and repair them. In addition, the MDF provided flexibility in connecting outside plant and wire center equipment -- the frame was completely "non-blocking," in that any outside plant pair could be connected to any appropriate central office circuit by changing the cross-connect. Such a change of course involved manual labor, but in the early part of the century, manual work was common and was needed to provide much of the functionality that the network offered.

28. The basic design of the MDF has remained largely unchanged for nearly a century. As the network grew, however, the MDF became congested and inefficient. For example, where, because of customer churn, a loop went out of service,

the jumper wire was often simply left on the frame. While that approach avoided time-consuming work on the frame, minimized the risk of breaking other cross-connects adjacent to the one being worked on, and thus was less costly in the short run, leaving unused cross-connects on the MDF only worsened the congestion problems. In Attachment 4, I show a photograph from the 1970s of an overloaded MDF.

29. As a result, by the 1960's, engineers were looking for ways both to reduce congestion on the MDF and to reduce the amount of manual activity associated with the MDF. These problems were summarized in 1971 in the basic patent that I hold on the automated distributing frame:

> Although substantial improvements in technology have occurred in automatic switching systems in the intervening years [since introduction of the MDF], the basic main distributing frame design has not changed in over half a century. . . . [Although the MDF permits flexibility and requires low plant investment,] the continuing need for investment in labor is extremely high. In addition, existing frames in many cases have grown far beyond their initially estimated sizes, thus forcing unreasonable measures to be taken to provide the necessary capacity. Massive reterminations, the physical requirement that portions of the [MDF] be segregated and interconnected with large cross-connection tie cables, and the phenomenal growth of individual switching system offices have contributed to maintenance problems, which in some instances have rendered many cross-connection changes impossible or at least prohibitively expensive.

Patent No. 3,562,435, A.E. Joel, Jr., Switching System With Automated Main Distributing Frame (Issued February 9, 1971).

30. The introduction of newer switching technologies helped reduce much of the congestion and inefficiency at the MDF. In addition, engineers, including myself, considered other ways to address the problem of congestion at the frame. These included both improvements to the basic MDF design as well as more radical efforts to automate the MDF or even to replace it entirely.

31. One ambitious approach involved replacing the MDF with an automated frame that would permit the cross-connect function to be performed automatically and from a remote location. As I mentioned, I hold the basic patent for an

automated MDF (Switching System with Automated Main Distributing Frame, 3,562,435, issued February 9, 1971). This patent represented the first significant effort to automate the manual processes associated with the MDF. Bell Labs conducted research during the early 1970s on my idea and other promising versions of an automated MDF, and constructed a laboratory model. They determined, however, that automated frames were extremely costly and could not, in most cases, economically be placed into service. As I understand it, at least one company has recently developed a smaller and less ambitious automated MDF, and Bell Atlantic proposes to require competitors to use this to recombine network elements. As I will discuss in Part II, I do not view that proposal as feasible or cost-effective.

32. Meanwhile, advances in technology for the switch and the loop made much of the manual work at the MDF unnecessary. For example, as I will discuss below, development of stored-program-control switching has made it possible to connect or disconnect service for customers electronically without manual intervention. It is thus no longer necessary to dispatch a technician to the MDF to lay-in or lift a cross-connect or perform other manual work.

33. In addition, ILECs are increasingly using digital rather than analog loops to serve customers. The loop that terminates on an MDF carries an analog signal that is converted to a digital signal, typically at the line card on the switch. The trend today, however, is to convert analog signals to digital at a remote terminal located as close to the customers' premises as possible. The digitized signals are then multiplexed onto a digital carrier system (typically IDLC), and transmitted to the central office. These digital loops cannot be individually separated and cross-connected at the MDF; instead, each passes through a digital cross-connect and then goes directly into the switch. With IDLC, there is neither the ability nor the need to make cross-connections at the MDF.

2. The Switch

34. Like the task of connecting outside lines with inside plant at the MDF, switching also began as a manual process. Because it is not practical to connect each network user directly and permanently to each other user, networks need a switching function to connect the parts of the network that a particular caller needs in order to select and connect to a called party. For the first 50 years or so, that function was performed manually by operators. A customer wishing to make a call first called an operator and relied on her to make the connections by connecting plugs and jacks at the switchboard as necessary to complete the call. For toll calls, the operator also manually recorded the call information on a ticket that was later used to prepare the customer's bill.

35. After decades of work, engineers developed gross-motion electro-mechanical switches (e.g., panel and step-by-step) that eliminated the need to have an operator manually connect the lines of calling and called parties. The subsequent introduction of the electromechanical "crossbar" switch then greatly improved the speed and reliability of call processing and added functionality. But the most important improvement was the introduction of stored-program control (SPC) switching, which used electronic technology to store the logic of switching system actions in the memory of the switch itself (a process I have elsewhere referred to as placing "switching logic in memory" or "SLIM"). The introduction of SLIM put a kind of intelligence in the switch, enabling it not only to perform its traditional call-processing functions faster and more accurately but to provide additional functions and capabilities, including new operations, administrative, and maintenance procedures.

36. For example, SPC switching has greatly improved the speed and flexibility of call processing. It has facilitated the use of databases located outside the switch as well as a separate signaling network to further improve network efficiency and enhance functionality. Similarly, it has permitted engineers to integrate the memory of call information recorded by the switch with a vast array of computerized operation

support and administrative systems. In short, the network has undergone a software revolution that has transformed its operations and capabilities.

37. One notable example of this transformation is in the reduction of work needed at the MDF. Cross-connections are no longer used to connect a particular loop with the directory number assigned to a particular port. Instead, the task of associating a particular directory number and set of services and features with a particular loop is made electronically via a software change in the relevant database in the switch. The cross-connection is usually left in place. Similarly, the task of disconnecting service for a customer no longer requires a craft visit to the MDF. Once again, a software change accomplishes that task.

38. The specific process used to make these changes to the loop/switch interface is known as "recent change." Recent change refers to the use of memory, separate from the switch's principal databases, that is allocated for recording and implementing changes to customer-specific information. In developing electronic switching, it was recognized early on that it would be safer and more reliable to make service order changes initially in a separate database and then, periodically, to update the principal databases with all of the accumulated recent changes. Through the use of recent changes, service may be initiated, changed, discontinued, or suspended without a craft visit to the central office. Recent change orders may be scheduled to take effect at a particular time, and may be processed in batch. Through recent change, a carrier may also choose not to disconnect service entirely, but to provide a limited service (e.g. "warm dial tone") that allows calling only for emergency 911 or to the carrier's business office.

39. An example illustrates how recent change has made much manual work at the frame unnecessary. If I were to move to a different house in my neighborhood, my local exchange carrier could, in theory, transfer my service manually to my new address, first by dispatching a technician to lift the cross-connect that connected my old loop with a switch port and replacing it with a cross-connect from my new loop to

that same switch port, and then by making the appropriate recent changes to record the new equipment assignments.

40. The same result can and would be achieved more simply by leaving the existing cross-connections in place, and using the recent change process to disconnect service to my old loop and to re-assign my switching information to the new loop. Disconnecting service to the old loop via recent change would remove dial tone from that loop (unless it was thought desirable to provide warm dial tone for emergency service) and cause the switch not to receive or process any dialed digits from that loop; the loop would thus be separated from the switch every bit as effectively as if an analog cross connection had been removed. Meanwhile, reconnecting service to a new loop via recent change would associate all of the information about my service and features with that new loop. This step is essential to make a functioning connection between the new loop and switch; it would have to be done regardless of whether any new cross-connections are made. In this way, recent change is used to connect and disconnect loops with the switch without the need for manual work at the MDF.

41. The ability to use software to control the way the switch carries out its functions, including that of connecting the elements of the network, has fundamentally changed telecommunications. Software intelligence has allowed the consolidation of better and new functionality within the switch, accomplishing functions that previously had been accomplished solely or partly through manual or mechanical processes, and permitting new functions that could not have been provided manually or mechanically. At the same time, the use of software has led to enormous gains in reliability and efficiency, reducing the cost not only of maintenance and repair, but enabling the network's resources to be used in the most efficient manner. Having made a successful transition to a software-based intelligent network, it is difficult to endorse any hardware solution to a given network design problem if a software solution can be found.

II. EVALUATION OF PROPOSALS FOR COMBINING NETWORK ELEMENTS

42. Using the criteria and historical context presented in Part I, I now turn to an evaluation of various proposed methods of combining network elements. Of course, I am not a lawyer and do not purport to offer legal definitions or conclusions. Instead, I will offer an opinion based on engineering understanding and judgment. In this affidavit, I assume that to "combine" an ILEC's network elements means to "connect" them. I first discuss the manual processes involving MDF jumpers for connecting elements put forth by BA-NY, and then turn to the electronic method involving recent change proposed by AT&T.

A. Manual Processes

1. Physical Collocation

43. Bell Atlantic's first proposal is physical collocation, an approach which uses multiple MDFs (the existing ILEC's, as well as the new CLEC-owned frames placed in collocated space) and other equipment to combine elements. From an engineer's point-of-view, even without considering the specifics of the proposal, combining elements using an MDF is suspect. It is undesirable to add new equipment, points of failure, and manual labor to the design of the network if that can be avoided. When the equipment (the MDF) at the heart of a proposed approach belongs to the network design of the past, the utility of such an approach becomes even more dubious. Because the MDF is outdated for modern switching systems, an engineer would rely on it only as a last resort, if other alternatives were not feasible. Moreover, because of IDLC technology, many loops are not available for cross-connection on the MDF, and therefore cannot be connected there with jumpers, tie-cables, and so on for transmission to a CLEC's frame.

44. At every turn, the collocation process introduces significant inefficiency and degrades the quality and reliability of service. For example, at the outset,

competitors must incur the time and expense of obtaining collocated space in each of the central offices that serve customers that they wish to serve. They do this simply to obtain space to install their own small MDF -- a 19th century piece of equipment that adds no functionality or quality to the service the competitor is trying to provide.

45. The collocation process also requires the ILEC to add clutter to the central office that is at best functionally useless and for which there may simply be no room. For example, in Bell Atlantic's approach, Bell Atlantic would need to install new, additional connector blocks on its MDF, on both the line side and the switch. The new blocks are needed so that Bell Atlantic can install new tie cables from the both the line-side and the switch side of the MDF, and run them to the CLECs' collocated space. This approach is ridiculous. Consider that if CLECs succeeded in attracting half of the ILEC's market (a reasonable assumption, since no carrier has more than half of the long distance market), and that half of the CLEC's market was served via unbundled loops or unbundled loop/switch combinations (a conservative assumption, given the limited resale competition to date), the ILEC would have to increase the size of its MDF by at least 25 percent to accommodate that growth. I do not think there are many central offices that would have the extra room needed to accommodate that sort of expansion. And even if there were enough room, the complexity and congestion that would accompany that kind of expansion runs precisely counter to historic efforts to minimize the size of the MDF and reduce the need for work at the frame.

46. The unnecessary and potentially harmful network tinkering does not stop here. Once this initial equipment is in place, more work is necessary to combine the elements for a particular customer. Every time a CLEC wins a new customer, an ILEC frame technician will need to be summoned to lay-in a new cross-connect on the ILEC frame, from the customer's loop location at the loop-side of the ILEC MDF to a new loop-side location on the newly installed connector blocks, also on the ILEC MDF. Then, the technician would repeat that process for the switch side of its MDF. This is

precisely the sort of manual work that network designers have tried over the years to eliminate from the network. Such work would be expensive, would introduce an opportunity for human error that threatens to degrade reliability, and would delay the provision of service. Yet, in return for this decrease in efficiency and reliability, the customer would not receive any compensating increase in functionality.

47. After that step, the technician would remove the original cross-connect on the ILEC MDF that ran between the loop-side and the switch-side, which would cause the customer to lose service. Then, the technician would connect the new cross-connects that had just been laid in. The central office frame technician also would have to coordinate this activity with the technicians remotely located in the ILEC's software center to have the customer's service moved to the newly assigned switch port. After both the physical work on the frame and the software work in the switch is complete, and after the line is tested for proper continuity, service for that customer would be restored. From an engineering point-of-view, a network design alternative that results in a network outage is automatically suspect. Here, the duration of the outage is uncertain but significant, and in some cases will be further extended if, for example, testing reveals problems with the cutover, or if human error disrupts the process.

48. All of the problems I just described would be compounded if, as is the case in many Bell Atlantic central offices, the ILEC used an intermediate distributing frame (IDF) in addition to its MDF. Use of an IDF would require additional connector blocks at the IDF as well as at the MDF, and would introduce yet more cross connects and therefore more manual work and more opportunities for human error, degradation of service, and significant increased cost.

49. An approach to combining network elements that requires new jumpers at the MDF does not advance any of the criteria for network design that I identified at the outset. Far from improving reliability, it makes matters worse. Virtually

every step involved adds delay and increases the risk of error, and the process as a whole increases the opportunity for service degradation and a prolonged service outage.

50. The goal of efficiency is also compromised. The collocation process does not economize on human or capital resources. Rather, it adds substantial upfront costs that are required even to begin combining elements, as well as costs of manual processes that will be need to occur hundreds of times every day, i.e., each time a customer decides to change his or her local carrier.

51. The loss in reliability and efficiency is not counterbalanced by a single gain in functionality. At best, the customer has no more functionality than before, and if the customer has been rolled from IDLC to an analog loop in order to provision the service, the customer may experience a decrease in quality and functionality. Finally, the physical collocation approach runs counter both to engineering principles and to the evolution of network design by re-introducing and placing central reliance upon outdated functions like the MDF and analog cross-connects.

2. Virtual Collocation

52. Central office buildings frequently lack space to accommodate physical collocation. In these circumstances, Bell Atlantic proposes that the CLECs purchase an automated MDF to be placed in "virtually collocated" space -- that is, space within the central office that the CLEC cannot directly access. Virtual collocation still requires extensive manual processes at the ILEC MDF, including all of the steps described above of adding in new connector blocks, additional cross-connects, tie cables, and of taking the customer's service down. All that was said above about why an engineer would disfavor these processes applies equally here to virtual collocation.

53. In addition, because Bell Atlantic will not allow the CLECs to install a pre-wired MDF into virtually collocated space, CLECs would need to perform an additional task of provisioning the connection of each loop with the switch via remote

operation of an automated MDF. This proposal simply compounds the needless complexity, cost, and chance for error inherent in the manual approach. In this scenario, the provisioning of a single new POTS line requires coordination between the work needed to disconnect the customer's service and move it to a new switch port (which would occur via a recent change), the work needed on the MDF to install the new cross-connects and remove the old ones, and the work by the CLEC to operate the automatic MDF. If any of these three separate steps (necessarily handled by different technicians located in separate work centers) did not happen in perfectly coordinated sequence, the customer could experience an extended service outage. Thus, use of an automated MDF would not eliminate any of the manual work needed in physical collocation; it would simply add to the costs and risks. Although I hold the basic patent on the automated MDF, I see no reasonable use for it here.

3. Assembly Room and Assembly Point

54. Another Bell Atlantic proposal is to bring the cross-connection function into either a common room within the central office that will be shared by numerous CLECs (the "assembly room"), or to an enclosed space located outside but adjacent to the central office (the "assembly point"). Although the assembly room/assembly point approach may reduce some of the costs associated with collocation, it still requires all the manual processes at the ILEC MDF that I described above, and thus introduces needless service outage, new points of failure, and expense. Furthermore, requiring CLECs to share a common facility may introduce additional opportunities for error, conflict, and interference between users of the room. But even if such additional problems could be controlled, the assembly room/assembly point approach does not overcome the basic design flaw of having to rely on substantial manual work at the MDF that decreases reliability and efficiency and provides no compensating increase in functionality.

B. Electronic Methods -- The Recent Change Approach

55. AT&T's proposal is to permit CLECs to use the switching software, specifically the recent change process, to combine network elements. I have already discussed in Part I how recent change operates in the switch. To use recent change to connect elements, a CLEC would need to be given access to the switch's recent change memory so that the CLEC could establish or restore a connection between its new customer's loop and the switch; the CLEC would not need and should not be given the ability to make recent changes on any customer's lines that the CLEC had not won. I know that it is very feasible to create the firewalls needed to allow a CLEC to use the switch's recent change capability to connect network elements for the customers that it wins, without giving that CLEC access to perform recent changes for any other carrier's customers. ILECs currently have in place systems that allow their Centrex customers to perform a recent change on any line within the block of lines they control, but that prevent those Centrex customers from making changes to any lines not assigned to them. I see no technical reason why CLECs could not be given the ability to use the recent change capability of the switch to provision service for CLEC customers, in much the same way as the ILECs and their Centrex customers now use that capability today.

56. As I understand it, implementing the recent change proposal for combining elements would lead to some expense to develop the system modifications and deploy the relevant equipment. Because the recent change process disconnects and connects network elements electronically, using a computerized process that is now well-known, the recurring costs for changing over a customer will be much lower and the provisioning times will be much faster than those for Bell Atlantic's proposals.

57. An approach like Bell Atlantic's that requires jumpers to be lifted and replaced at the MDF will create significant service outages for customers. In contrast, while recent changes that disconnect the loop and switch also will lead to